

Incidence of patent furcal accessory canals in permanent molars of a Turkish population

F. Haznedaroğlu¹, H. Ersev¹, H. Odabaşı³, G. Yetkin¹, B. Batur¹, S. Aşçı¹ & H. İşsever²

¹Department of Endodontics, Faculty of Dentistry, ²Department of Public Health, Faculty of Medicine, İstanbul University, and

³Private Practice, İstanbul, Turkey

Abstract

Haznedaroğlu F, Ersev H, Odabaşı H, Yetkin G, Batur B, Aşçı S, İşsever H. Incidence of patent furcal accessory canals in permanent molars of a Turkish population. *International Endodontic Journal*, **36**, 515–519, 2003.

Aim To determine the incidence of patent furcal accessory canals in permanent molars of a Turkish population.

Methodology Two-hundred extracted teeth consisting of 50 maxillary first molars, 50 maxillary second molars, 50 mandibular first molars and 50 mandibular second molars from Turkish patients attending the Oral Surgery Department of the Faculty of Dentistry, İstanbul University, İstanbul, Turkey, were included in the study. After preparation of access cavities and removal of pulp tissue, the teeth were stored in 5.25% sodium hypochlorite for 1 h. Following double-sealing of the access cavities, all tooth surfaces except the furcation regions were covered with nail varnish. The teeth were stored

in 0.5% basic fuchsin for 1 week. The teeth were sectioned at the cemento-enamel junction and the presence of patent furcal canals was established by examining the pulp chamber floor with a stereomicroscope (10×) to determine staining.

Results Patent furcal accessory canals were detected in 24% of maxillary first molars, 16% of maxillary second molars, 24% of mandibular first molars, and 20% of mandibular second molars. No statistically significant differences were found between the tooth types.

Conclusions In a Turkish population, the incidence of patent furcal accessory canals on the pulp chamber floor of maxillary and mandibular first and second molars ranged between 16 and 24%.

Keywords: furcal accessory canal incidence, molar morphology, patent furcal accessory canals, Turkish subpopulation.

Received 20 May 2002; accepted 24 March 2003

Introduction

Hess (1925) demonstrated the presence of 'marrow canals' in approximately 17% of 3000 teeth using a vulcanite perfusion technique. Russel & Kramer (1956), Saunders (1957) and Kramer (1960) investigated the microvasculature of the pulp and demonstrated the presence of large vessels running between the root canal and the periodontal ligament, particularly in the bifurcation and trifurcation of human molar teeth. The finding that intercommunication between the pulp and the periodontium exists prompted research into the possible

pathologic consequences of this intimate relationship (Niemann *et al.* 1993). Many authors have demonstrated that following endodontic treatment, lesions previously periodontally treated often heal (Rossman *et al.* 1960, Hiatt 1963, Simring & Goldberg 1964, Rubach & Mitchell 1965). Seltzer *et al.* (1963) observed that pulp lesions had an effect on the severity of periodontal lesions, and periodontal lesions produce a degenerative effect on the dental pulps of the involved teeth. Periodontal disease was shown to manifest its cumulative effect on the pulp by inflammation, calcifications, apposition of calcified tissue, pulp tissue breakdown, fatty degeneration and resorption (Seltzer *et al.* 1963, Rubach & Mitchell 1965, Langeland *et al.* 1974). Sinai & Soltanoff (1973) could produce changes in the pulp of experimental rats through induced periodontal disease and *vice versa*.

Correspondence: Dr Faruk Haznedaroğlu, Department of Endodontics, Faculty of Dentistry, İstanbul University, Çapa 34390, İstanbul, Turkey.

The presence and characteristics of accessory canals between the pulp chamber floor and the furcation surface have been established by topographical studies using scanning electron microscopy (Koenigs *et al.* 1974, Perlich *et al.* 1981, Vertucci & Anthony 1986, Goldberg *et al.* 1987, Luglie & Sergente 2001) or dissecting microscopy (Burch & Hulen 1974). Patency is a prerequisite for an accessory canal to be involved in pathosis by acting as a passageway for irritants, which enter the pulp from the periodontium and *vice versa* (Lowman *et al.* 1973, Niemann *et al.* 1993). However, there appears to be a controversy in the literature with respect to the prevalence of patent furcal accessory canals in permanent molars (Lowman *et al.* 1973, Vertucci & Williams 1974, DeDeus 1975, Gutmann 1978, Niemann *et al.* 1993). Moreover, the morphology of pulp chambers varies greatly in different races and in different individuals within the same race (Green 1955). Therefore, the purpose of this *in vitro* study was to determine the incidence of patent furcal accessory canals of permanent molars in a Turkish population.

Materials and methods

Two-hundred mature teeth consisting of 50 maxillary first molars, 50 maxillary second molars, 50 mandibular first molars and 50 mandibular second molars extracted from Turkish patients attending the Oral Surgery Department of the Faculty of Dentistry, İstanbul University, İstanbul, Turkey, were selected for study. Teeth with gross calculus in the furcal area, carious lesions extending under the cemento-enamel junction, visible fractures or cracks, immature apices, fused roots and gross coronal tissue loss were excluded. No information was available on the reason for extraction, their clinical history or the patients' age and gender. The teeth were stored in saline at room temperature until use. All gross soft tissue was removed with a periodontal curette (Niemann *et al.* 1993), but no scaling or root planing was performed. Following numbering of the teeth, access cavities were prepared using a size 6 round bur in a high-speed handpiece with water spray. Pulp tissue was removed by means of a spoon excavator and fine barbed broaches, without damaging the internal furcation area. The specimens were submerged in 4 L of 5.25% sodium hypochlorite for 1 h, and the wide vessel containing the solution was agitated every 5 min to allow more rapid diffusion of the dissolved soft tissue within the solution. The teeth were then washed in tap water for 30 min and dried at room temperature for 24 h. The cavities

were temporized with a double seal consisting of dry cotton wool, gutta-percha and Cavit (ESPE, Premier Dental Products Co., PA, USA). All the external root surfaces except the furcation were covered with three coats of nail varnish. The furcation was designated as the surface between the roots that did not extend onto a root surface (Goldberg *et al.* 1987). Once the varnish had hardened, the specimens were placed in 0.5% basic fuchsin (Niemann *et al.* 1993) at 37 °C for 1 week. Following rinsing in tap water, the crowns were removed with a high-speed handpiece, a cylindrical bur and water coolant. The cut was made at the cemento-enamel junction so as to allow visualization of the pulp chamber floor. Following removal of the filling material, the specimens were evaluated at 10× by a stereomicroscope (Nikon SMZ-2T, Tokyo, Japan). When a tooth had to be discarded owing to procedural errors or detection of a fracture or a crack, it was replaced with one of the same type. Cracks were discernible as fine lines of dye. The presence of a patent canal was then established by observing the pulp chamber floor to determine staining. No attempt was made to determine the location and number of patent furcal accessory canals. All teeth were evaluated by two investigators. The data were statistically analysed by the Chi-square test to determine if any significant difference existed between molar types with regard to the incidence of patent furcal accessory canals.

Results

The incidence of patent furcal accessory canals in the molar teeth is given in Table 1. Patent furcal accessory canals were found in 12 maxillary first molars (24%) (Fig. 1), in 8 maxillary second molars (16%), in 12 mandibular first molars (24%) (Figs 2 and 3) and in 10 mandibular second molars (20%). Overall, the incidence of patent furcal accessory canals in the sample was 21%. There were no statistically significant differences between the tooth types in terms of the presence of patent furcal accessory canals.

Table 1 Incidences of patent furcal accessory canals in molar teeth

Type of molar	Teeth examined (<i>n</i>)	Number (%) of teeth with patent canals
Maxillary first	50	12 (24)
Maxillary second	50	8 (16)
Mandibular first	50	12 (24)
Mandibular second	50	10 (20)
Total	200	42 (21)



Figure 1 A maxillary first molar with staining at two different points (arrows) (original magnification 10 $\times$).

Discussion

A number of experimental methods have been used to assess the patency of accessory canals in the furcation region of multirooted teeth. However, some of these methods have limitations. Grinding to expose furcation canals is difficult as fine accessory canals and ramifications can be missed (Green 1955). Sectioning methods are hindered by the need for large numbers of serial sections to demonstrate that an accessory canal is patent throughout its entire length (Lowman *et al.* 1973). The inability of radiographic methods to visualize the three-dimensional aspect of the root canals (Pineda & Kuttler 1972, Hession 1977) and small canals (Vertucci & Anthony 1986) has been reported. Controversial findings were also obtained

from the studies conducted on decalcified teeth. (Vertucci & Williams 1974, DeDeus 1975). Dye penetration techniques, however, have proven their validity in demonstrating the patency of furcal accessory canals (Lowman *et al.* 1973, Gutmann 1978, Niemann *et al.* 1993).

Niemann *et al.* (1993) exposed the external furcal area to basic fuchsin and determined the incidence of patent furcation canals on the chamber floor ranged between 44 and 68% in 100 maxillary and mandibular first and second molars. They concluded that exposure of accessory canals in the furcal area of molars to 5.25% sodium hypochlorite for 1 h via the pulp chamber produced patency which was demonstrable by passive dye leakage, that is without using vacuum or pressure. In the present study, it was also concluded that the use of a relatively

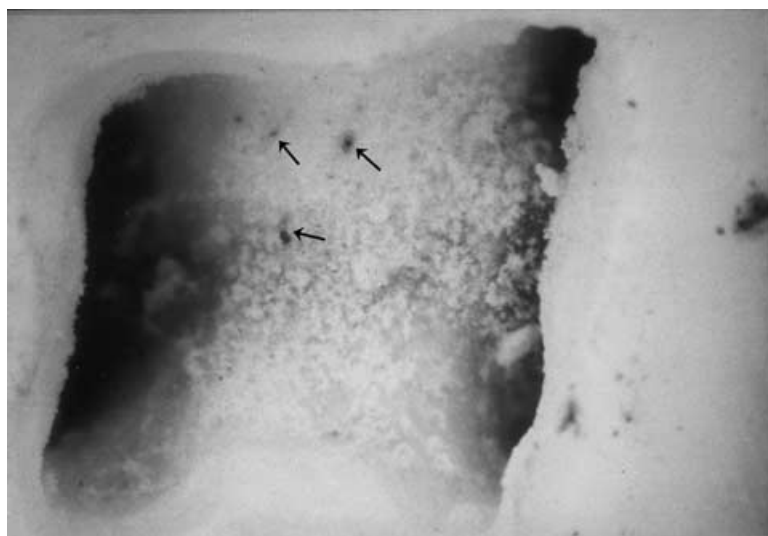


Figure 2 A mandibular first molar with staining at three different points (arrows) (original magnification 10 $\times$).



Figure 3 A mandibular first molar with gross staining of the pulp chamber floor owing to a very large patent furcal accessory canal (original magnification 10 $\times$).

high volume of sodium hypochlorite at a concentration of 5.25% for 1 h (Trepagnier *et al.* 1977, Thé 1979) with agitation would make the canals patent by dissolving soft tissue within them. The samples were kept in 0.5% basic fuchsin for 1 week instead of 24 h (Niemann *et al.* 1993). The incidence of patent furcal accessory canals detected in the present study was 21% and substantially lower than that found by Niemann *et al.* (1993). The difference between the two studies may result from racial differences. Variations in tooth anatomy and characteristic features between various racial groups have been reported previously (Green 1955, Gulabivala *et al.* 2002).

In spite of the use of a radiographic evaluative technique in conjunction with a radiopaque dye and vacuum, Lowman *et al.* (1973) found patent lateral and accessory canals in 59% of 46 maxillary and mandibular molars. However, the roots were planed with periodontal scalers, and they postulated that some occluded canals were made patent by this treatment. Exposure of accessory foramina in areas of denuded cementum has been confirmed by others (Stallard 1972, Vertucci & Anthony 1986). It has also been shown that a pulpal-periodontal communication can be established via exposed dentinal tubules (Seltzer *et al.* 1967, Stallard 1972, Gutmann 1978); this may occur following root planing.

Vertucci & Williams (1974), by injecting dye through decalcified teeth, detected 46% of mandibular first molars contained patent accessory canals in the 'furcal area'. However, they reported that the incidence of 'furcation canals' was 23%, which is consistent with the findings of the present study. Gutmann (1978) used a safranin dye penetration technique with vacuum from pulp cavity to periodontium and found that 24.5% of

102 maxillary and mandibular molars had canals in the 'furcation only'. Although no vacuum or injection pressure was used in the present study, the incidence of patent furcal accessory canal was similar to the ones reported by authors who have used vacuum (Gutmann 1978) or injection pressure (Vertucci & Williams 1974).

In an *in vivo* situation, accessory canals may become obliterated or calcified, or remain as viable channels containing normal tissue. In this way, they would not contribute to the spread of disease (Gutmann 1978). However, following root-canal treatment, owing to failure to seal the coronal aspect of the tooth adequately, unfilled accessory canals can become contaminated by ingress of fluids and bacteria from the periodontium (Gutmann 1978), or by oral fluids, when exposed in a periodontal pocket (Lowman *et al.* 1973, Vertucci & Anthony 1986). Moreover, when necrotic tissue and bacterial plaque are present in accessory canals (Gutmann 1978), or when endodontic pathogens can spread through unfilled accessory canals (Jansson & Ehnevid 1998), the progression of periodontitis may result.

Conclusions

Under the conditions of this study, patent accessory furcal canals were found in 21% of molars within a Turkish population.

References

- Burch JG, Hulen S (1974) A study of the presence of accessory foramina and the topography of molar furcations. *Oral Surgery, Oral Medicine and Oral Pathology* **38**, 451–5.

- DeDeus QD (1975) Frequency, location, and direction of the lateral, secondary, and accessory canals. *Journal of Endodontics* **1**, 361–6.
- Goldberg F, Massone EJ, Soares I, Bittencourt AZ (1987) Accessory orifices: anatomical relationship between the pulp chamber floor and the furcation. *Journal of Endodontics* **13**, 176–81.
- Green D (1955) Morphology of the pulp cavity of the permanent teeth. *Oral Surgery, Oral Medicine and Oral Pathology* **8**, 743–59.
- Gulabivala K, Opananon A, Ng Y-L, Alavi A (2002) Root-canal morphology of Thai mandibular molars. *International Endodontic Journal* **35**, 56–62.
- Gutmann JL (1978) Prevalence, location, and patency of accessory canals in the furcation region of permanent molars. *Journal of Periodontology* **49**, 21–6.
- Hess W (1925) *The Anatomy of Root Canals of Teeth*, London: John Bale and Sons and Danielsson, Ltd.
- Hession RW (1977) Endodontic morphology: II. A radiographic analysis. *Oral Surgery, Oral Medicine and Oral Pathology* **44**, 610–20.
- Hiatt WH (1963) Periodontal pocket elimination by combined endodontic-periodontic therapy. *Periodontics* **1**, 152–9.
- Jansson LE, Ehnevid H (1998) The influence of endodontic infection on periodontal status in mandibular molars. *Journal of Periodontology* **69**, 1392–6.
- Koenigs JF, Brilliant JD, Foreman DW (1974) Preliminary scanning electron microscopic investigations of accessory foramina in the furcation areas of human molar teeth. *Oral Surgery, Oral Medicine and Oral Pathology* **38**, 773–82.
- Kramer IRH (1960) The vascular architecture of human dental pulp. *Archives of Oral Biology* **2**, 177–89.
- Langeland K, Rodrigues H, Dowden W (1974) Periodontal disease, bacteria, and pulp histopathology. *Oral Surgery, Oral Medicine and Oral Pathology* **37**, 257–70.
- Lowman JV, Burke RS, Pelleu GB (1973) Patent accessory canals: incidence in molar furcation region. *Oral Surgery, Oral Medicine and Oral Pathology* **36**, 580–4.
- Luglie PF, Sergente C (2001) SEM study of morphologic and incidence of accessory canals in the furcation region of permanent molars. *Minerva Stomatologica* **50**, 63–9.
- Niemann RW, Dickinson GL, Jackson CR, Wearden S, Skidmore AE (1993) Dye ingress in molars: furcation to chamber floor. *Journal of Endodontics* **19**, 293–6.
- Perlich MA, Reader A, Foreman DW (1981) A scanning electron microscopic investigation of accessory foramina on the pulpal floor of human molars. *Journal of Endodontics* **7**, 402–6.
- Pineda F, Kuttler Y (1972) Mesiodistal and buccolingual roentgenographic investigation of 7275 root canals. *Oral Surgery, Oral Medicine and Oral Pathology* **33**, 101–10.
- Rossmann SR, Kaplowitz B, Baldenger SR (1960) Therapy of the endodontically and periodontically involved tooth. *Oral Surgery, Oral Medicine and Oral Pathology* **13**, 361–7.
- Rubach WC, Mitchell D (1965) Periodontal disease, accessory canal pulp pathosis. *Journal of Periodontology* **36**, 34–8.
- Russell LH, Kramer IRH (1956) Observations of the vascular architecture of the dental pulp. *Journal of Dental Research* **35**, 957.
- Saunders RL (1957) X-ray microscopy of human dental pulp vessels. *Nature* **180**, 1353–4.
- Seltzer S, Bender IB, Nazimov H, Sinai I (1967) Pulpitis-induced interradicular periodontal changes in experimental animals. *Journal of Periodontology* **38**, 124–9.
- Seltzer S, Bender IB, Ziontz M (1963) The interrelationship of pulp and periodontal disease. *Oral Surgery, Oral Medicine and Oral Pathology* **16**, 1474–90.
- Simring M, Goldberg M (1964) The pulpal pocket approach, retrograde periodontitis. *Journal of Periodontology* **35**, 22–48.
- Sinai IH, Soltanoff W (1973) The transmission of pathologic changes between the pulp and the periodontal structures. *Oral Surgery, Oral Medicine and Oral Pathology* **36**, 558–68.
- Stallard RE (1972) Periodontic-endodontic relationships, workshop on the biologic basis of modern endodontic practice. *Oral Surgery, Oral Medicine and Oral Pathology* **34**, 314–26.
- Thé SD (1979) The solvent action of sodium hypochlorite on fixed and unfixed necrotic tissue. *Oral Surgery, Oral Medicine and Oral Pathology* **47**, 558–61.
- Trepagnier CM, Madden RM, Lazzari EP (1977) Quantitative study of sodium hypochlorite as an *in vitro* endodontic irrigant. *Journal of Endodontics* **3**, 194–6.
- Vertucci FJ, Anthony RL (1986) A scanning electron microscopic investigation of accessory foramina in the furcation and pulp chamber floor of molar teeth. *Oral Surgery, Oral Medicine and Oral Pathology* **62**, 319–26.
- Vertucci FJ, Williams RG (1974) Furcation canals in the human mandibular first molar. *Oral Surgery, Oral Medicine and Oral Pathology* **38**, 308–14.